Design of a 50 Ton
Sulphite Pulp Mill

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Design of a 50 Ton Sulphite
Pulp Mill

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A DESIGN OF A FIFTY TON SULPHITE PULP MILL.

A THESIS PRESENTED
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OF THE
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IN
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By Walter H. Flood
And Victor Nicholson

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Accepted W. T. McClement
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Introduction.

It has been our aim in this thesis to make it a purely Chemical Engineering design, involving, as it does, problems both in chemistry and in engineering. The undertaking has proved larger than we had anticipated and consequently we have not gone into detail as much as we would have liked. We have endeavored, however, to bring in all the important parts, slighting only those of minor consequence. We have experienced considerable difficulty in procuring workable data in regard to various machines. This is especially true of some of the large manufacturers of modern pulp making machinery, although in most instances we have received prompt and courteous treatment.

The pulp mill in various views and details is shown on the annexed blue prints. No particular location has been chosen for the mill, but an abundance of clean water is necessary, and proximity to a large lake, or a river on which the logs can be floated, is desirable. It is also assumed that the mill has good transportation facilities and is near a large source of supply of spruce wood. The power plant and office building have been omitted, as they are not essential in the design; the power plant would be a complete design in itself and would vary in size according to whether or not water power were available. The mill is to be electrically lighted and the machinery elec-

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trically driven. The capacity of the mill is 50 tons dry sulphite pulp per day of twenty four hours; the pulp, however, is not dried, but is allowed to retain considerable water, as it is considered to be better in this condition by some paper manufacturers; space has been left to increase the capacity of the mill to 75 tons per day.

No attempt has been made to design the acid system as the Stebbins system has been adopted in many modern mills and is considered highly efficient. It is much more compact and less costly than the old tower system.

TABLE OF CONTENTS.

PROCESSES OF MANUFACTURE OF WOOD PULP--- 1

- Mechanical Process 1
- Soda Process 1
- Sulphite Process 2

THEORY OF THE SULPHITE PROCESS 3

DESCRIPTION OF METHOD USED 8

DESCRIPTION OF BUILDINGS--- 12

- Wood Department--- 13
    - Conveyors 13
    - Sawing Machines 13
    - Barkers 14
    - Chippers & Crushers 15
    - Rechipper 15
    - Chip Screen 15
- Digester Building--- 16
    - Digesters 16
    - Exhausters 18
    - Storage Bins 18
    - Blow Pits 19
- Acid System 19
- Finishing Building 21
    - Screens 21
    - Wet Machines 22
    - Stuff Chests and washers 22
    - Ware Room 22

COST 23

BIBLIOGRAPHY 27

Processes of Manufacture of Wood Pulp.

Paper consists of cellulose fibers matted or felted into a coherent sheet. The raw materials used are of various kinds, but by far the greater amount of paper now manufactured is made from wood fiber. There are two general methods of manufacture of wood fiber, mechanical, and chemical.

MECHANICAL PROCESS-The mechanical process consists in forcinga log of wood about 2 feet long against a revolving grindstone over which a stream of water plays. The resulting pulp is washed away by the water and passes to a set of screens, which remove pieces which have been insufficiently ground. The pulp then passes to a tank in which a cylinder covered with wire gauze revolves; this picks up a layer of pulp and delivers it on to an endless belt, which then passes through a number of rolls, where the water is squeezed out and the pulp compressed into a compact sheet; after which it is cut into sheets of convenient size. Mechanical fiber is contaminated with lignin and other resinous matter which turn brown on exposure to light. The fibers are short and do not mat together well, so that the paper made from it is not strong. Mechanical pulp is used only for cheap paper, and generally in conjunction with chemical fiber.

SODA PROCESS-Chemical fiber is now generally made by either of two processes, the soda process, or the sulphite process. In the soda process, the wood is cut into short lengths and chipped, that is to say cut into small

pieces running length wise with the grain. The dust is removed from the chips by blowing them against a screen and they are then put into a tall steel cylinder called a digester. The digester is nearly filled with chips which are then covered with a caustic soda solution of sp. gr. 1.15. Steam is blown in at 140 pounds pressure and the chips cooked for five or six hours. At the end of that time the pulp and "black liquor" are blown out into a tank where the pulp is systematically washed, the wash waters being saved, and evaporated and calcined to be used over again. The action of the caustic soda is two-fold; first, together with the steam under pressure it aids in breaking up the organic and other incrusting matters of the wood fiber; and second, it neutralizes the organic acids formed during this decomposition, which would otherwise char the cellulose. The caustic soda, however, has a detrimental action on the cellulose itself especially when the pressure is very high; some of the fiber is dissolved or destroyed, while all of it is weakened somewhat. The pulp produced is of a dark color, though easily bleached. Poplar is largely used in the soda process, and to a less extent cottonwood and basswood.

SULPHITE PROCESS-The sulphite process yields a fiber which in softness, strength and purity is superior to fiber made by any other process in general use. The first patent involving the use of sulphurous acid in reducing wood to pulp was that numbered 70,485 and issued Nov. 5, 1867 to Benjamin C. Tighlman then of Philadelphia, and a chemist to whom many branches

of technology are much indebted. A supplementary patent # 92,229, covering the treatment of fibrous materials at the ordinary pressure, was issued to the same inventor in 1869. These patents form the basis of all the various modifications of the process at the present time. The numerous subsequent patents to other inventors cover merely improvements in apparatus and details of treatment.

Tighlman states that his invention consists in a process of treating vegetable substances which contain fibers, with a solution of sulphurous acid in water heated in a closed vessel under a pressure sufficient to retain the acid gas, until the intercellular incrusting or cementing matter existing between the fibers is dissolved, either partially or wholly as may be desired, and a fibrous product is obtained suitable for the manufacture of paper pulp or fiber, or for other uses according to the nature of the material employed.

THEORY OF THE SULPHITE PROCESS-It is well known that many of the more complex members of the carbohydrate group to which cellulose belongs, undergo more or less pronounced change upon being boiled with water, especially if the boiling is conducted at the higher temperature obtained under pressure in a closed vessel. Sugar, which is a typical member of the group, becomes inverted, that is, the sugar combines to a limited extent with the elements of water, and the more complex molecule, thus formed, breaks down into two simpler ones of dextrose and

laevulose. Such an action, in which as a result of taking up the elements of water a molecule is broken down, is called a hydrolytic action, and the decomposition itself is called hydrolysis. Similar changes, as before stated, are brought about through the action of water alone upon the more complex carbohydrates, such as cellulose and its incrusting matters, if not on all the members of the group. These changes, however, proceed far more rapidly and completely in the presence of dilute acids. Cellulose itself is comparatively stable under these conditions, unless the temperature is considerably raised, but Tauss and others have shown that it is by no means unacted upon. Lignin, probably from its greater complexity, is broken down with considerable rapidity at temperatures not much higher than the boiling point of water. The products of the decomposition are largely organic acids, and the direction of the decomposition is toward the production of these acids, but among the earlier products there undoubtedly occur a considerable proportion of substances having at least the general character of the aldehydes. When the ordinary mineral acids, such as sulphuric or hydrochloric, act in the dilute form and at a moderately high temperature upon wood, the decomposition products rapidly accumulate in the liquor, and undergo further secondary decompositions, the course of which tends toward the production of insoluble, dark-colored and tarry matters. It is obviously impossible under these conditions to look for the

production of cellulose in any condition of purity.

The reaction undoubtedly takes a somewhat similar course when sulphurous acid without any base is used, indeed, this acid is well known to have a decomposing action upon many groups of organic compounds. As a reducing agent, using the word in its chemical sense, the acid retards and limits the secondary changes, but it does not altogether prevent them.

The primary action of a bisulphite liquor in resolving wood proceeds upon the same lines as that of a solution of sulphurous acid, but the presence of the base in this combination materially modifies the subsequent course of the reactions. The bisulphites possess the remarkable property of forming, with the aldehydic products of the first stage of decomposition, true double compounds which are soluble and comparatively stable. Compounds of this class have been found in the waste liquors. It is characteristic of the aldehydes that they pass by oxidation into organic acids, and in spite of the sulphurous acid which tends to prevent the oxidation, there is some formation of these acids. Once formed they displace the sulphurous acid from an equivalent portion of the base and form soluble organic salts. By these two actions the bisulphites take up the products of the resolution of the wood and prevent for the most part the extreme degredation of the products, which is characteristic of the water treatment or of the soda process. The combination of the acid products with the base is shown by

the steady rise of the gas pressure during the last part of a sulphite cook, and which is avoided by blowing off. It is also shown by the composition of the waste liquors. A. Ihl finds that the resinous matter obtained by evaporating these liquors consists mainly of the calcium salts of acids similar to arabic acid, and that these acids, as indicated above, decompose carbonates, sulphites and sulphides.

An incidental advantage of considerable importance is obtained by the use of sulphurous acid in connection with a base, and is due to the power of this acid to form, with various coloring matters, compounds, which themselves are colorless. The practical effect of this latter action is the production of a fiber, which may be at first of a color as good as that of a well bleached pulp, although, as in the case of all sulphurous acid bleaching, this color does not persist for any considerable length of time.

Although all the bisulphites act in general in the manner specified above, the character of the liquor is modified in several important particulars, according as one base or another is in combination with the acid. Bisulphite of lime is a very unstable salt, which upon being merely heated decomposes, one half of the acid being set free. The resulting monosulphite is practically insoluble, so that when this decomposition occurs in the boiler, this latter salt is precipitated throughout the pulp from which it is removed with difficulty by wash-

ing. Therefore when lime liquor is used, there is more gas pressure in the digester and the resulting pulp is comparatively hard, harsh, and transparent. It is also more difficult to make a straight lime liquor of high test than it is to prepare similar liquors from magnesia and soda, but on account of the insolubility of sulphate of lime the former never contain over 3% of sulphuric acid, while sodium or magnesium liquors may contain an indefinite amount. In the case of calcium liquors any excess of sulphate over the amount given is precipitated and may be settled out.

Bisulphite of magnesium is somewhat more stable than the corresponding calcium salt, and its action on the incrusting matters is milder but even more effectual. The sulphates or monosulphites which may be present in magnesium liquors remain in solution and are easily washed out from the pulp. The resulting product is much whiter and softer than any which is ordinarily made with lime without some subsequent treatment. These desirable qualities are possessed in a still higher degree by soda. Sodium bisulphite is not so permanent that it may be easily obtained and preserved in the crystalline form. The gas has so strong an affinity for the base that liquors of 35° Bé. may be made without difficulty. Both the sulphate and sulphite of soda are very soluble, and hence there is no precipitation either in the liquor apparatus or in the digester. Pulp made with soda liquor is white and soft, and

almost entirely free from the lost portions of incrusting matter.

It has been held by some that sulphuric acid in considerable quantities is formed in the digester during boiling, but numerous experiments show that in reality this oxidation of the sulphurous acid is very slight. It is obviously so, when we consider that making no allowance for the chips and liquor in the digester, but supposing the whole interior to be filled with air at the ordinary temperature and pressure, the total quantity of oxygen contained therein amounts to only 22# in a digester of 1200 cubic feet, a quantity so small when compared to the weight of sulphurous acid in the liquor that it may be disregarded.

It is seen from the foregoing discussion that sodium bisulphite makes the best liquor. Although this is true, it is as yet too expensive for practical use, and a mixture of calcium and magnesium bisulphites is almost universally employed. The bisulphite liquors are made by passing sulphur dioxide through towers packed with dolomite over which water is trickling; or by leading sulphur dioxide into closed vessels containing milk of lime (prepared from dolomite).

Description of Method Used.

There are, practically speaking, six different methods of

producing sulphite fiber. The processes differ only in the manner in which the wood is treated with the acid liquor and not in the preliminary sawing and chipping. In the annexed design the Quick Cook Unbleached Method is employed, the name explaining itself; the raw material is spruce wood.

The logs as received at the mill from the forest are cut into twelve foot lengths. They are conveyed from the storage yard to the saw which cuts them into two foot lengths in one operation. The logs then pass onto another conveyor which carries them to machines for removing the bark. These consist of revolving disks having knives which rotate longitudinally to the log. The latter rests on adjustable supports and is slowly rotated by means of an automatic barker attachment thus exposing new surfaces of bark to the knives and diminishing waste due to irregular cutting when turned by hand. Practically the only manual labor necessary up to this point in the process is to carry the logs from the conveyor to the barker, adjust the support to the size of the log and carry the barked log back to the conveyor.

From the barker the logs now stripped of bark are conveyed to machines which cut the logs into chips and then splits up the chips into small pieces to expose greater surface to the action of the acid liquor. These combined chippers and crushers consists of a large steel disk having a number of knives placed radially on one side, and a number of steel pins

on the other side, projecting perpendicularly to the face of the disk. The disk is enclosed in an iron casing on the lower part of which, on the inside, steel pins similar to those on the disk project. The log is taken from the conveyor and is placed in a spout-shaped sup ort making an angle of about 30° with the disk. The weight of the log is sufficient to keep it against the knives, cutting it into chips which pass through slits in the disk to the side on which are the steel pins. The chips pass between the rapidly revolving pins, and the stationary ones on the casing, and are then drawn out through the bottom by a blower, which delivers them onto a revolving cylindrical screen with its axis making an angle of about 30° with the horizontal. The chips are delivered at the upper end of the screen, the small pieces falling through, while the oversize passes down to the lower end from where it goes to a rechipper. This consists of a heavy disk running on a steel shaft, and carrying on its periphery eight knives. These knives, passing by three bed knives attached to the casing of the machine, recut the material as it passes through. The chips from the rechipper are blown back to the screen, so that no large pieces of wood find their way to the digester.

The chips passing through the screen are caught in a bin, from where they are blown, to large bins over the digesters. The digesters are filled about three fourths full of chips from the bins, through a hopper arrangement. The acid liquor is

then pumped in from storage tanks; about 30,000 gallons are used in a charge, or about 1200 gallons per cord of wood. Steam is then run in under 100# pressure. After about ten hours the pressure in the digester rises rapidly and the contents of the digester are blown into a large concrete box, called the blow pit. Here the pulp and black liquor separate to some extent, and the pulp is pumped to stuff chests, in which the pulp is thoroughly washed in running water. The stuff chests are horizontal wooden sylinders, through the center of which a shaft revolves, carrying a number of wooden paddles which keep the pulp stirred up. From the stuff chests the pulp is pumped to centrifugal screens situated in the wet room. Here, any slivers of wood unacted upon by the acid liquor are removed and returned to the digester. From the centrifugal screens the pulp flows to storage tanks, where water is mixed with the pulp to make it the proper consistency. The tanks contain stirrers to keep the mixture uniform, and to prevent the pulp from separating from the water. The pulp is pumped from the storage tanks to the vats of the wet machines. The wet machines consist of a cylinder of wire gauze six feet long partly submerged in a vat of pulp; above this cylinder and touching the top of it is a wide band of felt which passes over, and under a number of wooden rollers. As the wire cylinder revolves it picks up a layer of pulp and delivers it onto the felt, and, passing between the rollers, is freed from most of

the water , being delivered at the end of the machine, where an attendant cuts it into sheets six feet long with a doctor knife. The sheets of moist pulp then go to the warehouse to be shipped to market.

Description of Buildings.

All buildings are to be of brick, and with the exception of the acid making building are to be of fire-proof construction throughout. All interior work in the acid building is to be of white pine. Basement floors will be of cement laid according to standard practice. Other floors are to be of reinforced concrete. All windows to be glazed with wire glass; window sashes, frames, doors, and door frames other than those used in the acid building will be made of pressed steel. On all buildings, save the acid making, the roofs will be of reinforced concrete covered with a tar roofing, and supported on steel trusses. On the acid building the roof will be of wood, covered with a tar roofing similar to the others. Girders, columns, etc., other than those mentioned are to be of steel. All skylights, ventilators, metal windows and doors are to be furnished by the E. Van Noorden Co., Boston, Mass. All reinforced concrete construction in the buildings is to be done by L. J. Mensch, Chicago, Ills. The roofings are to be laid

by the Barrett Manufacturing Co.

Wood Department.

CONVEYORS-The conveyors for carrying the logs from the water to the storage ground, and from the storage ground to the saws, consist of a steel cable, carrying clamps, and moving in a wooden runway. The clamps can be moved any distance apart to suit the length of log. The advantages of this system are simplicity, cheapness, flexibility, and small power required for operating. The conveyors, with all necessary trestle work and appurtenances, are to be installed by the Jeffrey Manufacturing Co., of Columbus, Ohio.

SAWING MACHINES-The automatic sawing machine is made by the Waterville Iron Works, Waterville, Maine. It consists of the necessary hard pine frame, to which is attached saw arbors carrying five circular saws placed in position to cut the wood into two foot lengths. The log is carried to the saw by means of carrier chains to which are attached brackets, or dogs, the stick being placed on the table ahead of these dogs. The carrier chain being in continuous motion, a log if placed ahead of every bracket keeps the saws in cut almost constantly. This machine will do a large amount of work, and is very efficient.

BARKERS-The barkers used are also made by the Waterville Iron Works. The machines are made wholly of metal, weight about 4000 pounds each and are thoroughly built. The shafts are made of steel, with long bearings, and run in self oiling boxes. The disks are turned and balanced. The outside of each disk is hooped with a heavy Norway iron band to prevent breaking, when running at a high rate of speed. Attached to the back of each disk are fans making it a powerful exhaust fan for removing the bark and waste material from the machine.

Each barker is provided with a device for adjusting the brackets that support the logs while in the cut, raising and lowering them at the will of the operator as the wood varies from large to small diameter. There is also a simple device for sustaining the thrust of the log, giving the least possible friction.

On the back of each machine is a small door, which provides easy access to the knives, for the purpose of adjusting or removing them. The barkers used in this design carry six knives each, and take wood up to 27 inches in diameter.

Each barker is equipped with a Lombard Barker attachment, made by the Waterville Iron Works. This consists of a suitable frame, bolted to the top of the barker, to which is attached a chain, driven by a sprocket and supplied with sharp spurs. The shaft to which the sprocket is attached is driven by a belt from a pulley on the barker shaft.

In operating the barker, the log is first placed in position on the brackets; the chain is then brought down, the spurs coming in contact with the log, causing it to revolve with an even motion, thus securing a uniform cutting of the knife. These attachments add very materially to the efficiency, ease of operating and saving of wood.

CHIPPERS & CRUSHERS-The machines for chipping and crushing are known as the Shortt Patent combined chipper and crusher, and are built by the Baker and Shevlin Co., Saratoga Springs, N. Y. They are of metal throughout and are very solidly built. These machines are comparatively recent devises in the pulp industry and have met with great success, as they do away with the expense and trouble of an extra machine.

RECHIPPER-For recutting the chips which are too large, the Lombard Rechipper, made by the Waterville Iron Works, is used. The description of it may be found on another page.

CHIP SCREEN-The Lombard Chip Screen, also made by the foregoing company, is employed to remove the large chips, sawdust, dirt, etc., from the good chips. The screen consists of a cylinder, composed of five sections, making an angle of about 15° with the horizontal and supported on two parallel shafts, carrying pulleys which bear on hoops, separating the sections of the screen. Motion is imparted to the shafts by means of bevel gears in mesh with gears on a third shaft carrying a pulley and belt; the shafts in turn rotate the screen. The first or upper three sections of the screen are covered with

perforated metal, which allows all the sawdust, dirt, etc., to pass through, leaving the chips to be carried into the next section. The last two sections are fitted with slats, between which the good material passes, leaving the long slivers, knots, etc., to be carried out at the end. The machine is provided with a device for preventing the chips from clogging the spaces between the slats, thus securing an unrestricted passage for them.

Digester Building.

The digester building, being higher than the others, is to be built more solidly. The walls are to be 24 inches thick at the bottom and are to have a batter. The foundations are to be of concrete and very solid, especially under the digesters.

DIGESTERS-The digester shells are to be erected by either the McNeil Boiler Co., Akron, Ohio, or the Manitowoc Boiler Works, Manitowoc, Wisconsin, depending on the location of the mill. Each and all of the shell plates are to be 1 1/8 inches thick and the outside covering plates 1 1/4 inches thick, of open hearth flange steel, having a tensile strength of at least 50,000 pounds per square inch of section. Elastic limit to be not less than half the ultimate strength. Elongation to be not less than 22% in a length of 8 inches. The longitudinal seams are to be triple and the circumferential seams double

riveted. Rivets must completely fill the holes and have full holes concentric with the rivet and in full contact with the surface. The rivets are to be of steel 1 1/4 inches in diameter and of the same quality and standard as that required by the U. S. government for similar vessels and work. There are to be eight supporting brackets riveted to the discharging conical end of the shell, rivets to be countersunk on the inside of the shell, also eight supporting columns, the contact bearing parts of the brackets and columns are to be faced, and holes drilled, the columns to be cast of tough gray iron. The brackets to be of cast steel. The digester when completed is to be subjected to and tested to a hydrostatic pressure of 130 pounds per square inch and to be perfectly tight at that pressure.

The lining for the digester is to be of Acid Proof Vitrified Non Absorbent bricks, laid with a mixture of the pulverized brick and Portland cement. These bricks are manufactured by the New York Brick and Paving Co., of Syracuse, New York, and have shown no deterioration after several months immersion in a 50% solution of sulphuric acid.

The pipes which convey the acid liquor from the storage tanks to the digester, and those through which the pulp is blown from the digester to the blow pits, are of iron, lead lined. They are to be furnished by the Lead Lined Iron Pipe

Co., Wakefield, Mass. The pumps for forcing the acid liquor into the digesters are of the centrifugal type, and composed of stoneware. They are made by Frederick Bertuch and Co., New York, N. Y. The valves controlling the flow of the pulp into the blow pits are lead lined, and are manufactured by the Baker & Shevlin Co., Saratoga Springs, N. Y.

The pipe bringing the steam to the digester enters about three fourths the way up, and connects inside the digester with a perforated bronze pipe placed vertically. The steam is forced through the perforations and rises up through the liquor, heating it and causing it to act on the chips.

EXHAUSTERS-The exhausters used in the various places for blowing the chips are built by the Green Fuel Economizer Co., Matteawan, N. Y. The side plates or housings are made from a high grade of steel plates. The plates are riveted and bolted to a frame composed of angle irons. The wheel is constructed of steel plates, with steel tee arms and cast iron hub, fitted onto the shaft with taper key and set screws.

STORAGE BINS-The bins above the digesters for holding the chips are to be built of half inch steel plates, riveted to I beams placed two feet apart, the whole being supported on built up girders, and braced with I beams. The hopper at the bottom is to be of sheet steel, with a slide gate of the same material, and an extension steel pipe at the bottom. Both the

gate and pipe are operated by levers placed on the floor above the digester. When the digesters are charged with chips the cover is unclamped and swung aside, there being a joint in the acid liquor pipe to provide for this.

BLOW PITS-The blow pits are to consist of reinforced concrete, lined with neat Portland cement. They are covered with the same material, manholes being provided for cleaning and repairing the pits. There is also an opening in the top, for connection with a flue for conveying the sulphur dioxide fumes into the air. This flue is of reinforced concrete, lined with a layer of neat Portland cement. The whole contrivance is to be practically air tight, so that no corrosive gasses will escape inside the building.

Acid System.

The acid making system represents the most recent and economical development along this line, and is the cheapest up to date plant in the world. Since it was introduced in 1904 by the Stebbins Engineering and Mfg. Co., Watertown, N. Y., several of these plants have been installed.

The department (A) is what is commonly known as the Liquor Making room. The department (B) is the Sulphur Burning room. The department (C) is the Sulphur Storage room, and the department (D) the Lime Storage and Lime Slacking room. (C) and (D)

form a two story room.

Referring to department (A), the figure (1) represents the latest type of liquor making apparatus. This contains four compartments, two for the proper distribution of the gases, and two for the liquor under process of making into bisulphite. These compartments are formed and built up by means of heavy steel I beams, securely riveted and further tied together by means of rods in all directions. This steel work is incased in solid walls of special concrete, and the interior of the apparatus is lined with a tight and acid resisting lining, the whole when completed forming an air tight, hermetically sealed vessel, fitted with agitators and all other appurtenances required for the complete absorption of the gases into finished bisulphite liquor.

The figure (2) represents the location and pulley of a bronze metal acid liquor pump that is used for the purpose of transferring the finished bisulphite liquor from the apparatus (1) into the storage tanks (3).

The figures (4) and (5) represent Lime Storage vessels; (6) represents a double effect sulphurous gas cooling appliance; and (7) represents a duplex exhauster.

Referring to department (B) the figures (8) and (9) represent sulphur burners of the rotary type.

Referring to departments (C) and (D), the figures (10) and

(11) represent iron lime slacking tanks.

The complete plant except the building itself and the storage tanks but including all other accessories is to be installed by the Stebbins Engineering & Mfg. Co.

The storage tanks used are of yellow pine, and are built by the W. E. Caldwell Co., Louisville, Ky.

Finishing Building.

The finishing building is constructed of similar materials to those in the wood building. In the wet room, the screens and wet machines are set up on concrete foundations.

SCREENS-The screens, which remove any slivers unacted upon by the acid liquor, are built entirely of metal with the exception of the wood step which supports a little of the weight of the cylinder to which the screen plates are bolted. The screen is conical shaped and contains the cylinder referred to above, which carries the screen plates. There are two parts to the screen, one inside the cylinder, called the sliver chamber and containing the pieces of wood removed from the pulp, and other between the cylinder and outside shell which contains the screened stock. The cylinder carrying the screen plates revolves at about sixty revolutions per minute. The pulp to be

screened enters at the bottom through a centrifugal pump, and the screened pulp passes out through a pipe in the side, near the bottom. The screen is known as the Moore Rotary Screen, and is manufactured by the Moore Screen Co., Sandy Hill, N. Y.

WET MACHINES-The wet machines are designed to secure compactness, in order to lessen the amount of floor space, and at the same time all parts are very heavily built. The vat is of the best quality of cypress wood; the machines are equipped with patent friction clutch pulleys, supported in ring oiling boxes on floor stands. The machines are manufactured by the Waterous Engine Works Co., Brantford, Canada.

STUFF CHESTS & WASHERS-The stuff chests and washers are made of cypress. The washers are horizontal and are equipped with mechanical stirrers and pipes for the entrance and discharge of the wash water. The stuff chests are vertical and are similar in construction to the washers with the exception of the pipes. The stuff chests are for the storage of the pulp before it goes to the wet machines.

WAREROOM-Room is provided at the end of the Finishing building for the storage of the finished product, previous to its transportation to market. Sufficient space is supplied for storing of two weeks output. Large sliding doors open on to a platform for loading the pulp on railroad cars.

COST OF CONSTRUCTION.

	Digester and Finishing Buildings.	Wood Building.	Acid Building.
Excavations	$ 392.40	$ 135.63	$ 50.70
Foundations	4770.	1596.	1200.
Brickwork	13620.	2949.12	1996.80
Roof Trusses	2847.	665.	
Concrete and tar roofs	5297.60	2310.	272.60
Plain concrete floors	2992.	1300.	1134.
Reinforced concrete floors	6340.	3250.	
Windows	1296.	1008.	800.
Doors	1150.	310.	195.
Skylights and ventilators	1486.50	150.	
Columns, girders, and I beams	4250.	2860.	360.
Miscellaneous	1565.	1480.	1150.
Total cost of construction	$46106.50	$18113.75	$7159.10

TOTAL COST OF BUILDINGS.

Digester
-and-
Finishing Buildings.

Cost of construction	$ 46106.50
Digesters	21000.
Chip bins	2500.
Blow pits	1082.
Chimney	967.
Centrifugal pump	150.
Wet machines	5400.
Screens	2700.
Washers and stuff chests	3000.
Stuff pumps	922.
Motors	3000.
Digester lining	3640.
Piping and valves (lead lined)	8475.
Shafting and pulleys	1650.
Total Finishing Building	$100492.50

WOOD BUILDING.

Cost of construction	$18113.75
Conveyors	8960.
Sawing Machine	1025.
Barkers	2750.
Chippers and crushers	2800.
Rechipper	125.
Chip screen	400.
Blowers	180.
Piping	200.
Shafting and pulleys	425.
Motors	4500.
Hopper	150.
Total for Wood Building	$39628.75

ACID SYSTEM.

Cost of construction	$ 7159.10
Cost of apparatus	28433.
Cost of storage tanks	2711.41
Total cost of Acid System	$38303.51

Total cost of plant exclusive of power plant	$178,424.76

COST OF OPERATION.

	Per day.
Wages and superintendence	$ 500.
Fixed charges (12% total investment)	100.
1400 H. P. ($40.00 per H. P. year)	150.
Spruce logs	800.
Sulphur	200.
Lime	40.
Total expense	$1790.
Daily Income	2000.
Daily Profit	$ 210.
Return on Investment	37%.

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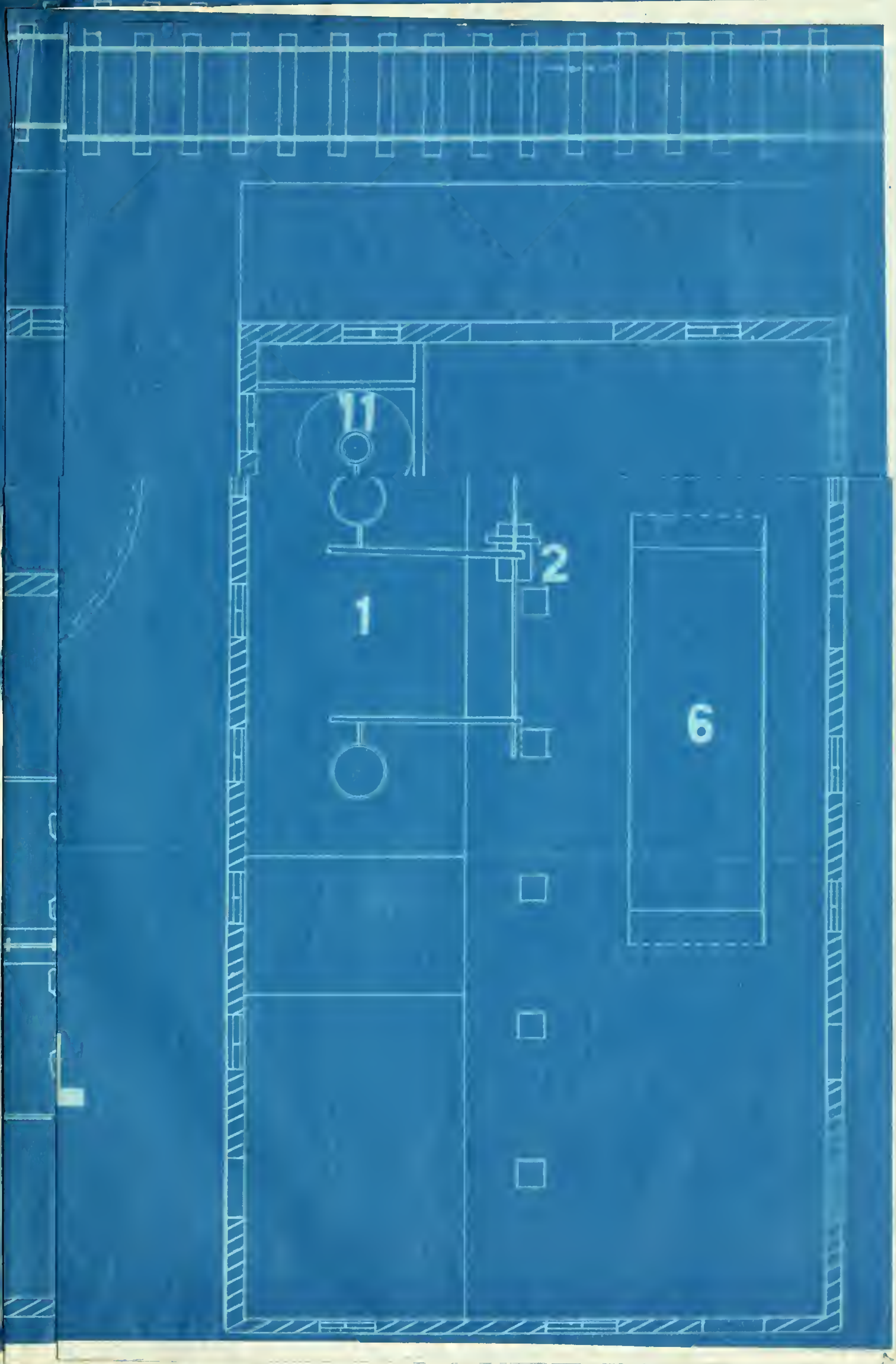
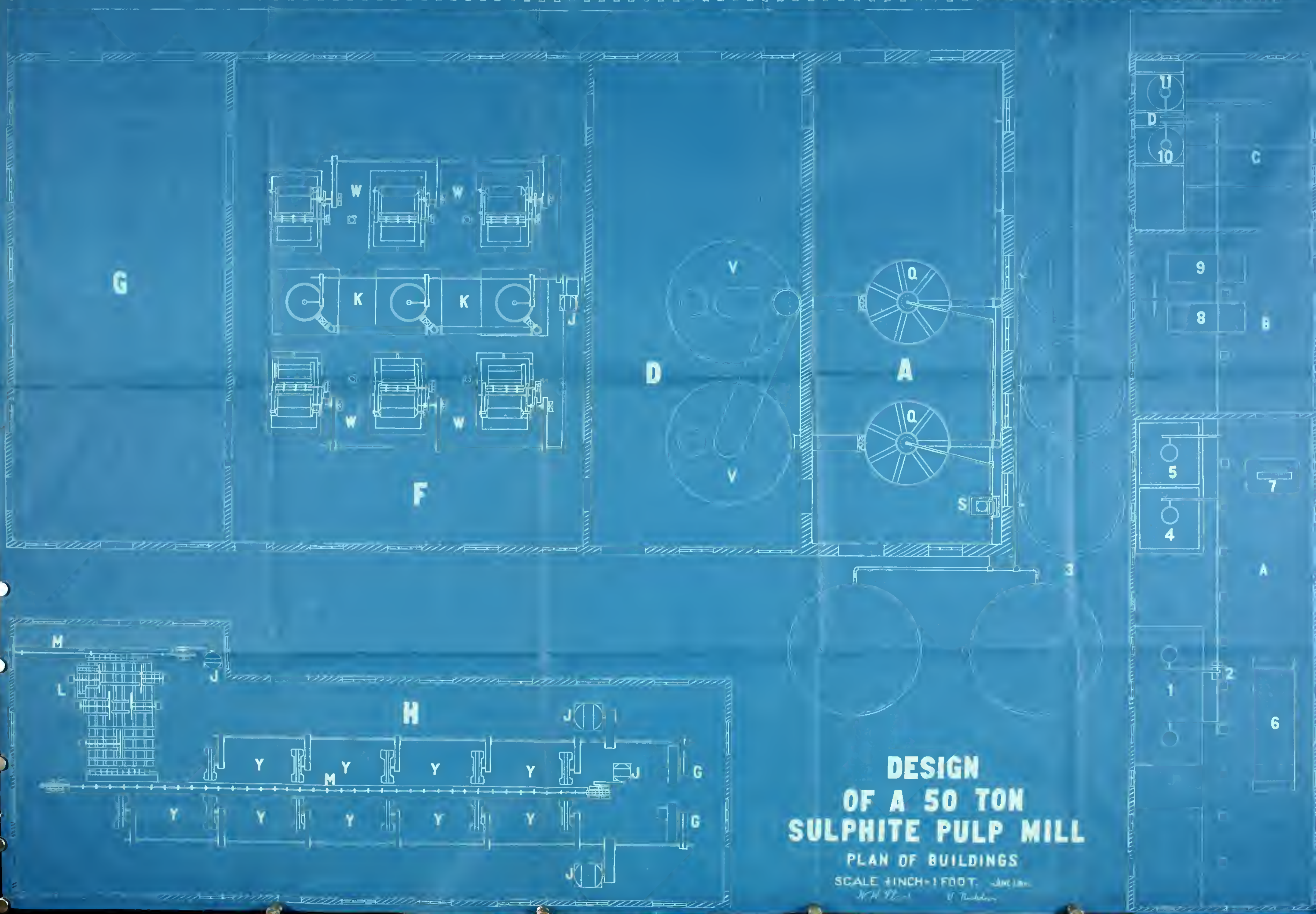
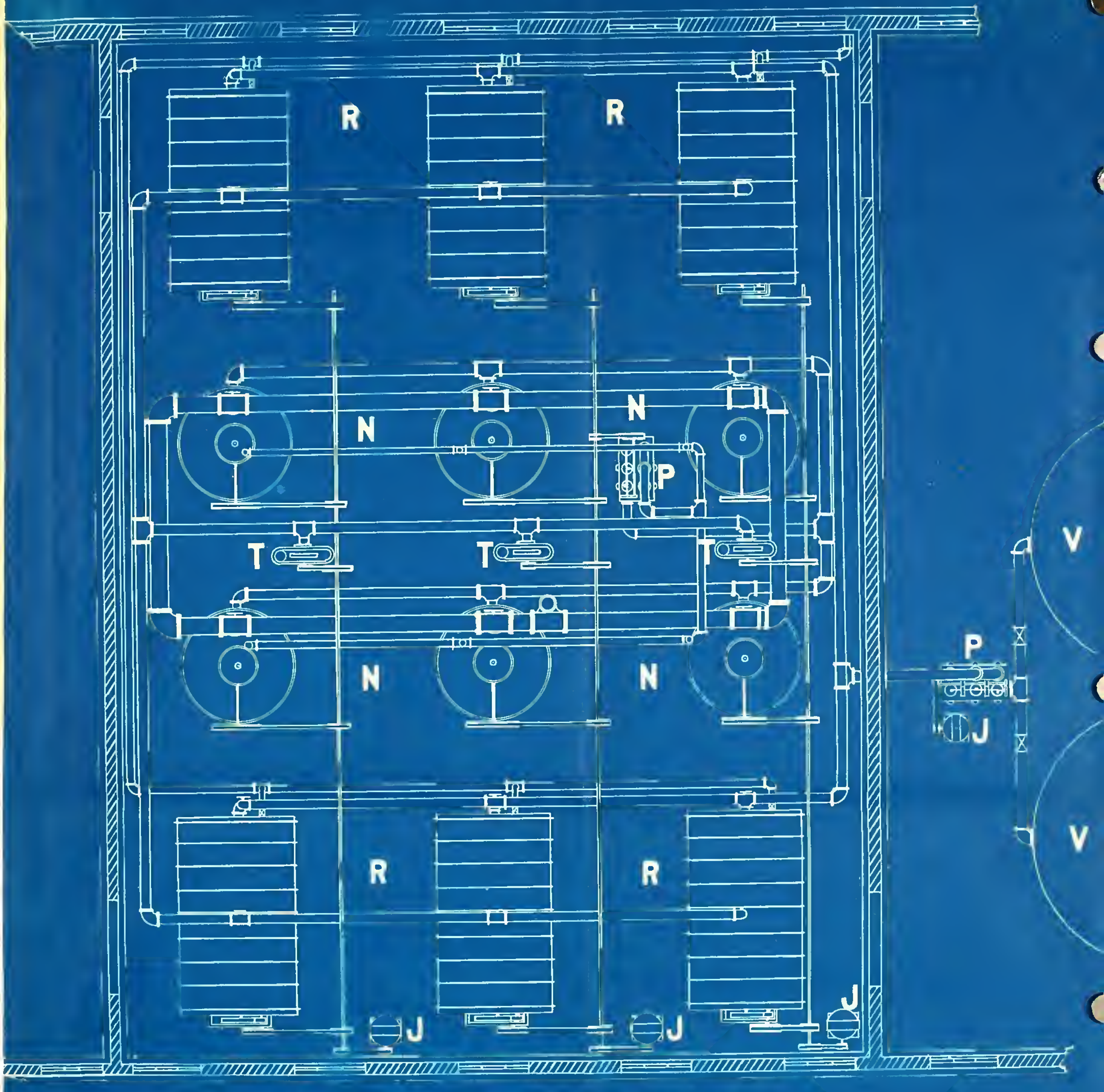




DESIGN OF A 50 TON SULPHITE PULP MILL

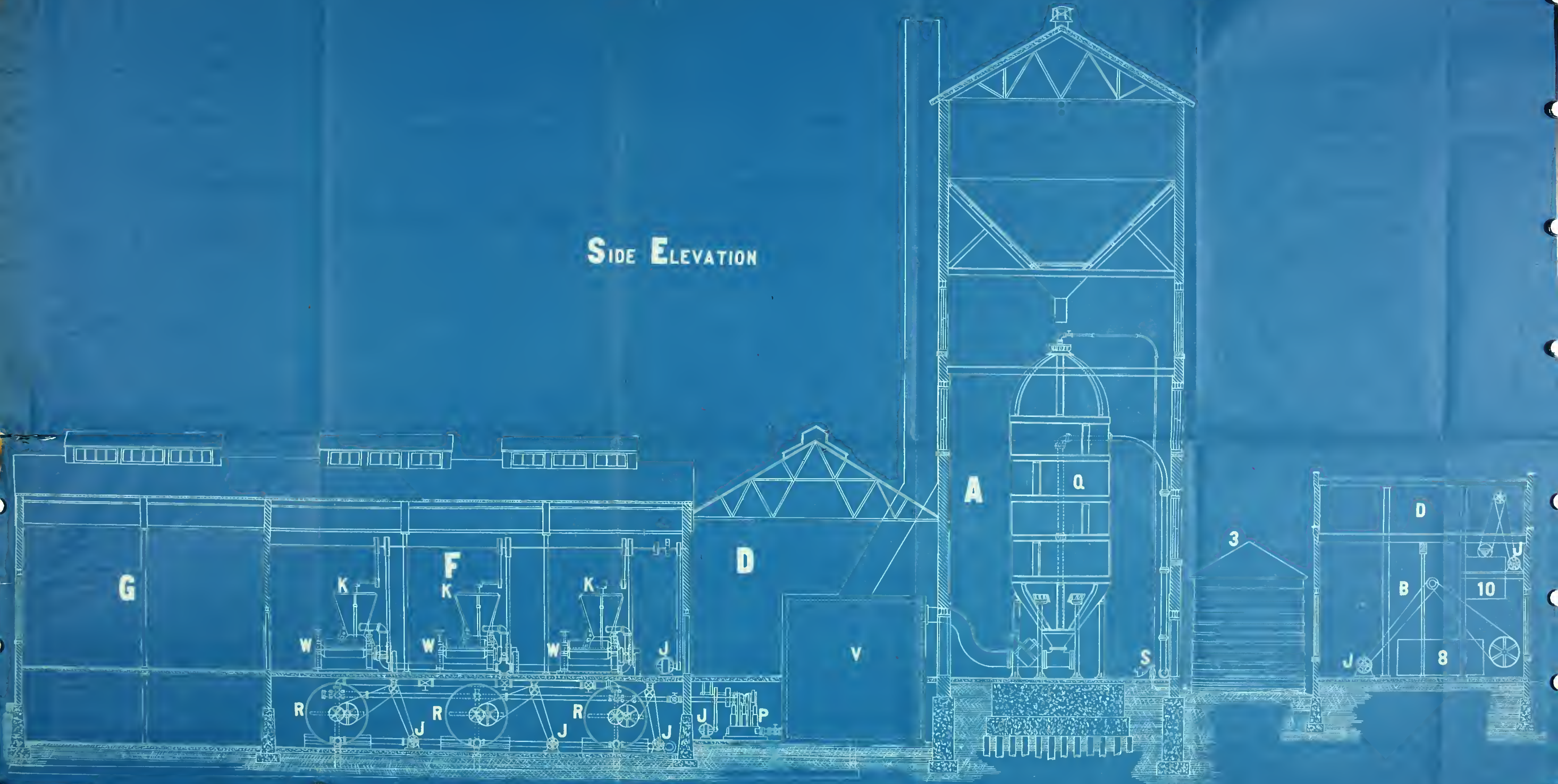
PLAN OF BUILDINGS

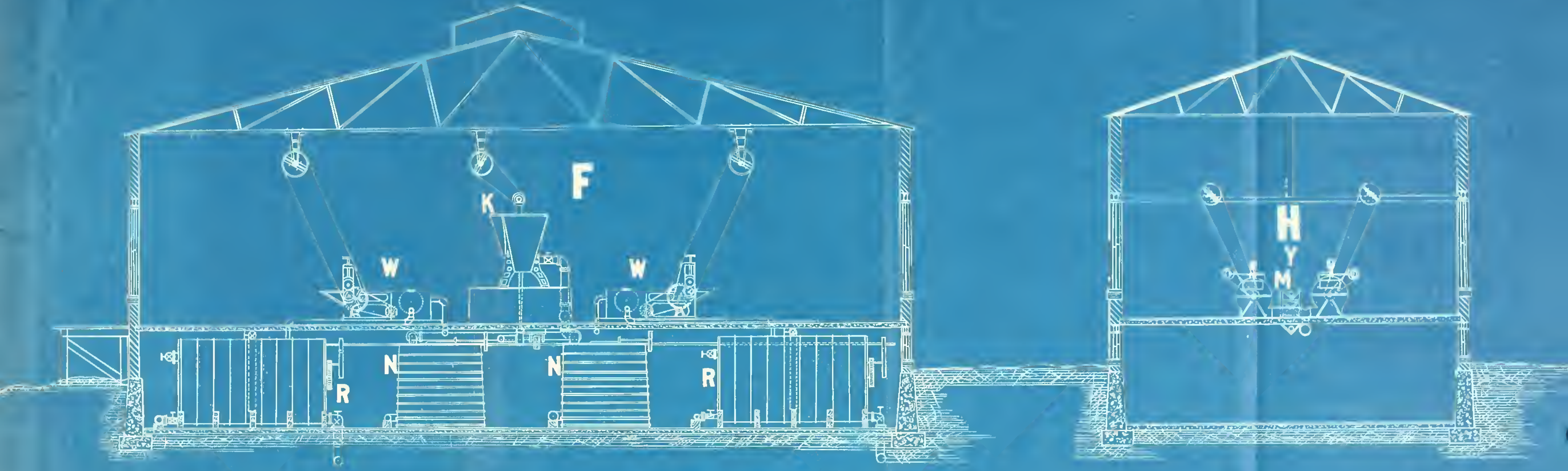
SCALE ⅛ INCH = 1 FOOT.



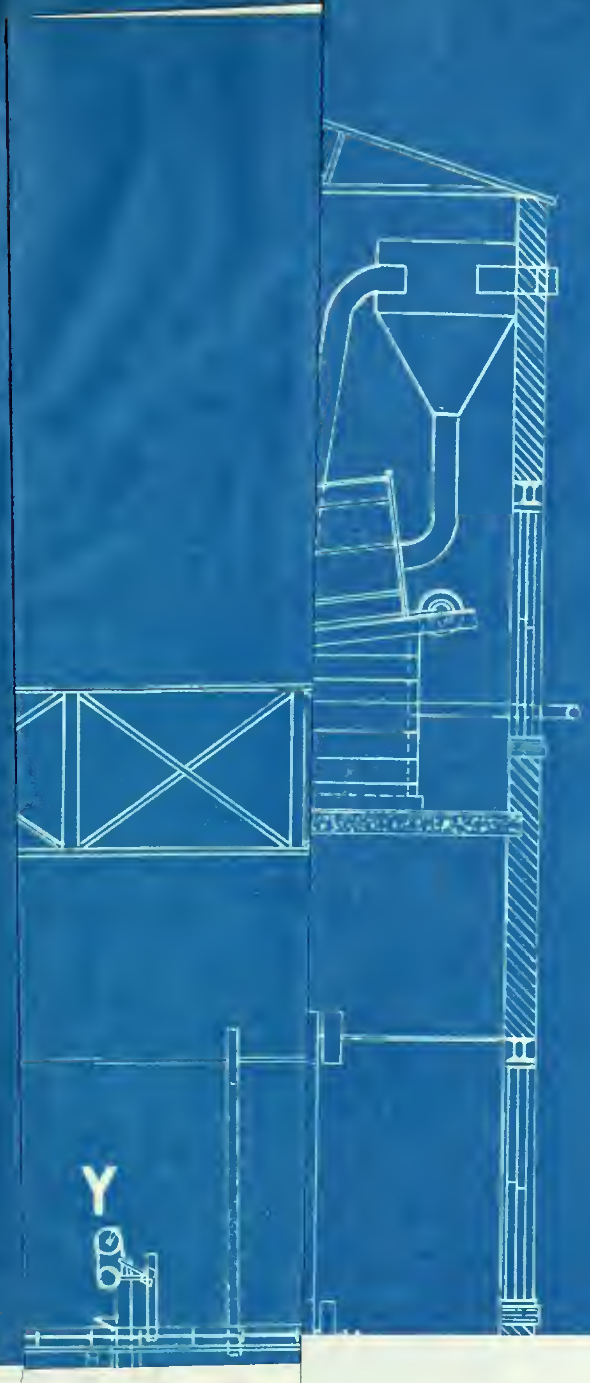
PLAN WET ROOM BASEMENT

SIDE ELEVATION

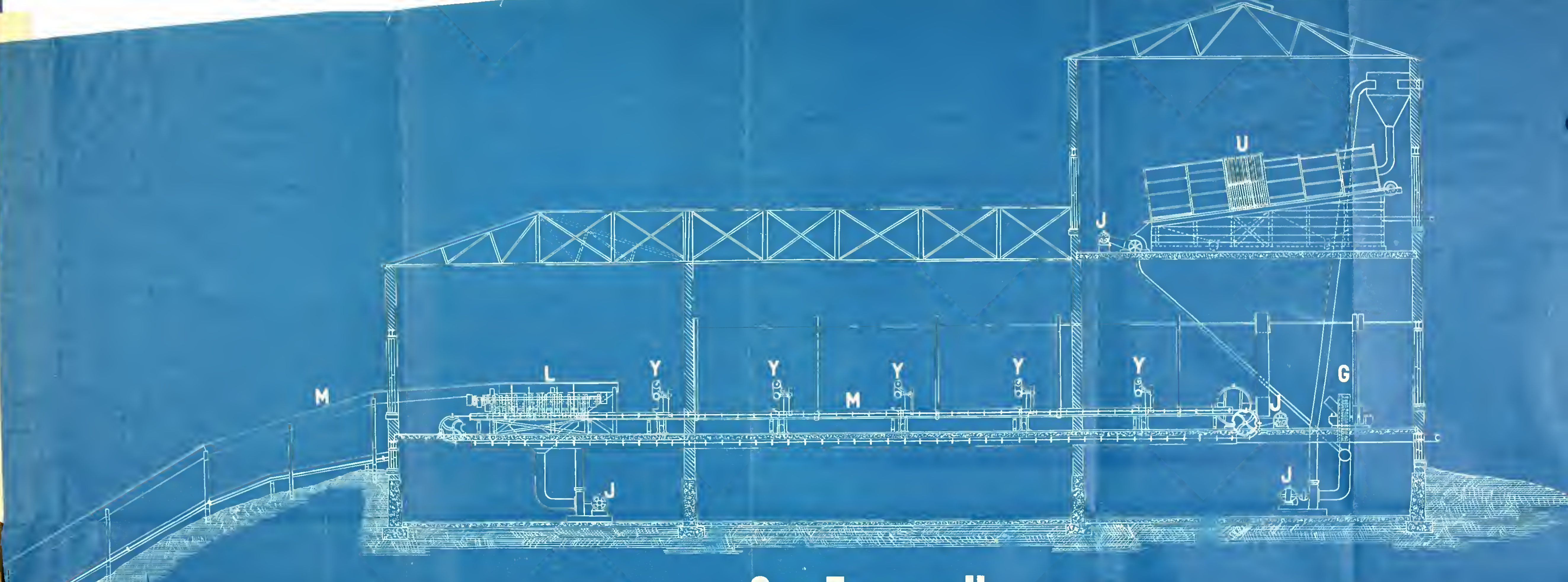




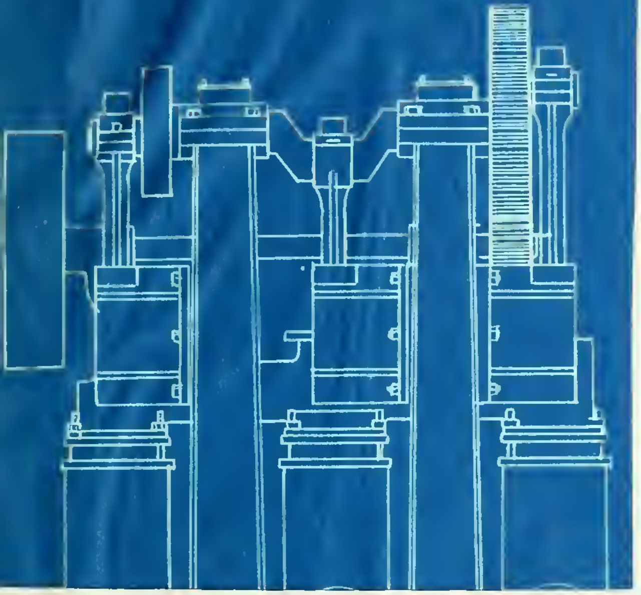
END ELEVATION



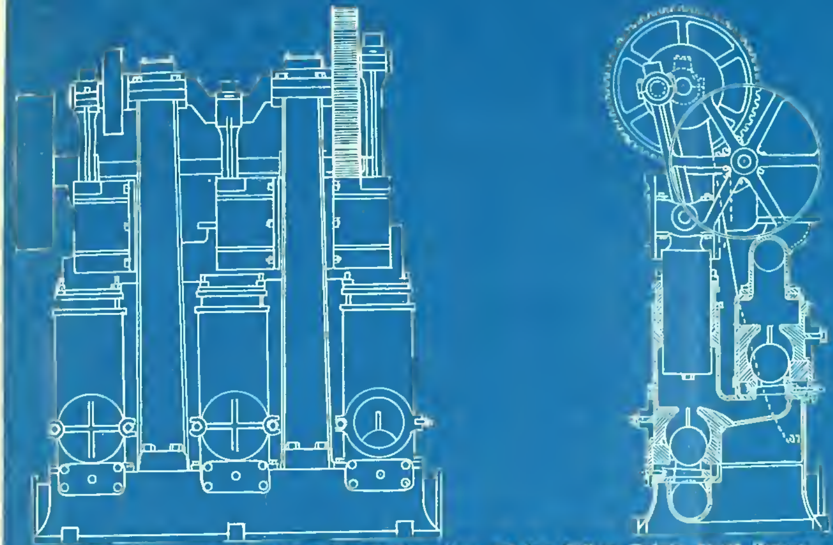
6 *Gas Cooler*
7 *Exhauster*



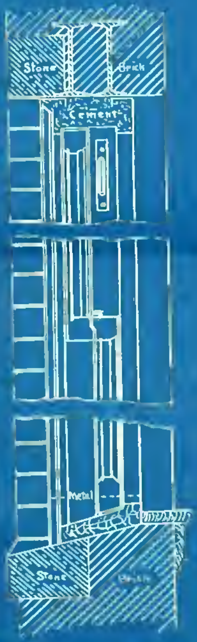
SIDE ELEVATION H



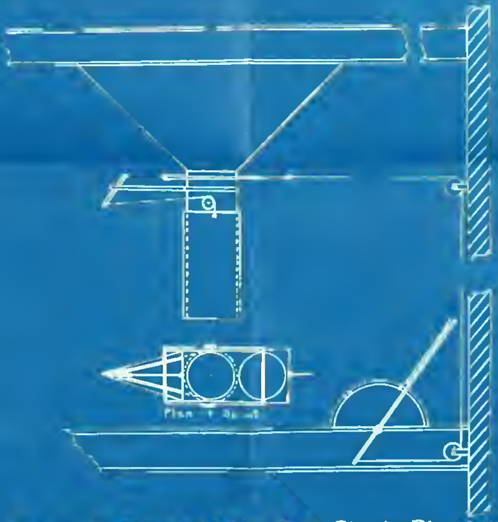
5 *Lime Storage Vessel*
6 *Gas Cooler*
7 *Exhauster*



Front Elevation and End Sectional Elevation of the Dillon Triple Stuff Pump.



The Van Noorden Metal Window.



Device for Running Chips from Bins to Digesters

A DIGESTER ROOM
Q *Digester*
S *Centrifugal Pump direct connected to motor.*

D BLOW-PIT ROOM
V *Blow-pit*

F WET ROOM
J *Motor*
K *Centrifugal Screen*
W *Wet Machines*

G WAREROOM

H WOOD DEPARTMENT
G *Chipper & Crusher*
L *Sawing Machine*
M *Log Conveyor*
J *Motor*
Y *Barkers*

A LIQUOR MAKING ROOM
1 *Liquor making tanks.*
2 *Bronze acid liquor pump*
3 *Storage Tanks*
4 *Lime Storage Vessel*
5 *Lime Storage Vessel*
6 *Gas Cooler*
7 *Exhauster*